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NATIONAL SCIENTIFIC BALLOON FACILITY

ANNUAL REPORT - 1 JULY 1976 - 30 SEPTEMBER 1977

I. SUMMARY

This report covers a period of 15 months, from 1 July 1976 through 30 September 1977. This change was caused by the change in the Federal fiscal year.

During this period we flew a total of 80 flights. Of these, 63 were from Palestine and 17 from remote locations. Sixty-three were in support of scientific research and 17 were in support of test and training. The overall interest in remote flights remains high, 21% of the total. We anticipate at least two (2) remote U.S. and one Southern Hemisphere expeditions per year for the next several years.

Our success rate is approximately that of the last several years, 88.7%. While the overall success record is stable, the NSBF is very concerned over the relatively high failure rate with remote launches and heavy payloads. We believe that the solution to most of these problems is the development of semi-permanent remote launch sites and special launch techniques for large balloons. NSBF efforts in these areas, however, will be entirely dependent on funding over the next few years.

The percentage of atmospheric science flights remained approximately constant, 22% of the total. Indications are that these flights will increase somewhat over the next few years.

Development work continued to be largely concentrated on the Long Duration Project although the effort on heavy load flight problems has increased.

II. OPERATIONS

FLIGHT SERVICES BY THE NSBF CREW

A total of 80 flights were flown during the 15 month period of this report. Of these 80, 63 were flown from Palestine, 2 from Sicily, 3 from Christchurch, New Zealand, 1 from Page, Arizona, 1 from Australia, 7 from Aberdeen, South Dakota, 2 from Malden,Missouri and 1 from Grenada, Mississippi.

We had a total of 9 failures, distributed by causes as follows:

Balloons - 6

Operations - 3

Balloons accounted for the majority of the failures. These were predominately large balloons, with only two (2) of the six (6) being smaller than 438,320 M^3. Three of the failures were at launch, the other three at float or going into float. Four of the six (6) were heavy payloads, greater than 1,746 kg.

Of the operations failures, two were remote flights. Both were ground aborts caused by unforecast wind shift during inflation, leaving insufficient running room for release. It is likely that both of these flights could have been successfully launched from Palestine.

The third operations failure was a parachute malfunction resulting in a free fall. The investigative board concluded that the most likely mode of failure was that the parachute streamed for approximately 30 seconds and then opened. This would have resulted in a shock load of approximately 80 g, far in excess of our normal 10-1 safety factor.

As to the remote failures, there are two separate failure modes. The first is meteorology. We are operating in an unfamiliar environment

and our meteorologists do not have the background of experience that they have at Palestine.

Secondly, we have operated at a number of sites and often have had to accept a site with bearly acceptable lay-out and run area.

To help this situation, we propose to standardize on two (2) locations, one in the northern U. S. and one in the central U.S. An expedition would be made to the high-latitude site in the fall, to the mid-latitude site in the spring.

Another factor leading to reduced efficiency in remote operations is the use of rental equipment for a launch vehicle. These are usually mobile cranes, and as such must be modified for use as a launch vehicle. More important, the crew is using different equipment on each expedition and never become completely familiar with the vehicle. The solution is to procure our own mobile launch vehicle, capable of heavy load flights. Funding does not appear possible for such a procurement in the near future.

Of particular note are the three successful super pressure scientific flights for Utah State University from Christchurch, New Zealand. The scientific payload was small, 20 kg, but these flights did prove the feasibility of light load, long duration scientific flights. Data retrieval and position information were obtained through the NIMBUS Satellite.

The average balloon volume increased to a new record of 366,738 M^3. The average payload weight was 934 kg, slightly below last years record high.

Two Argentines, Lt. Roberto Vazquez and Mr. Daniel Peralta of the Consejo Nacional de Investigaciones y Tecnics, arrived at the NSBF for operational training in August 1977. They will form the nucleus for an Argentina ballooning capability upon completion of training.

FLIGHT OPERATIONS IMPROVEMENTS

Due to difficulties with low level winds, both at Palestine and at remote sites, we have initiated a program of low level wind soundings, surface to 610 M. Members of the operations team have been trained in the techniques of taking these soundings and working up the data. Besides the obvious observational help, it is also anticipated that these soundings will assist the meteorologists in forecasting this phenomena.

The operational aspects of a dual balloon system such as the Sky Anchor is quite complicated. To assist in these launches, we have designed and built a new spool vehicle for these launches. It is a low profile vehicle and transportable. Preliminary tests have shown this vehicle to be most useful.

We have acquired a surplus crane vehicle and are converting it into a medium load launch vehicle. It should prove most valuable for remote launches as it is roadable.

We are planning on switching from styrofoam to fiberglass for insulation of flight packages. We lose nothing in insulation preparation and gain a great deal in fire protection.

The electrical helium valve used on valve flights is now being manufactured by the NSBF rather than procured from the balloon manu-

facturer. This has resulted in a savings of approximately 60% on each valve.

We have initiated a system of flight readiness reviews prior to each flight. These reviews are normally held within 24 hours of expected flight time. They are primarily for operations personnel, but occasionally attended by members of the scientific team. These meetings have proven most useful in giving a consistent and systematic approach to flight readiness.

ELECTRONIC IMPROVEMENTS

RANGING SYSTEM

A simple ranging system has been placed into operation. This requires a start pulse from the PCM Command Encoder to a time interval counter and a stop pulse from the command decoder "verify circuit" received via telemetry. The time interval is then used to calculate horizonal distance in miles, with the azimuth reading obtained from the telemetry dish antenna. Accuracy on the order of 10 miles or less has been obtained. Modifications are underway to improve this system.

COMPUTER

All digital tapes are now standard 9-track 800 BPI units. The alignment in which data is recorded has been changed from that used on 7-track units.

DATA LINK

A satisfactory test was made of a data link from the downrange telemetry station and Palestine. The bit error rate was on the order of 1 in 10^4 bits. We are investigating the feasibility of using a micro-processor in the downrange station to reduce the bit rate. This would permit use of a regular voice-grade line at considerable less cost.

TERMINATION COMMAND

The new PCM terminate command decoder was made completely operational in January 1977. Because of the high reliability of these units the back-up timer is no longer flown on a routine basis. Two independent decoders with minimum altitude circuits are used which eliminates the problems involved with resetable timers or setting timers for forecasted float winds.

OMEGA TRACKING

An additional Omega receiver/processor has been placed in operation to support launches from remote sites or when two flights are in progress at the same time from Palestine.

RADAR

An MPS-19 auto-track radar unit has replaced the M-33 radar for tracking of flights on ascent. This radar will also be used for wind soundings in place of the GMD-1 Radiosonde.

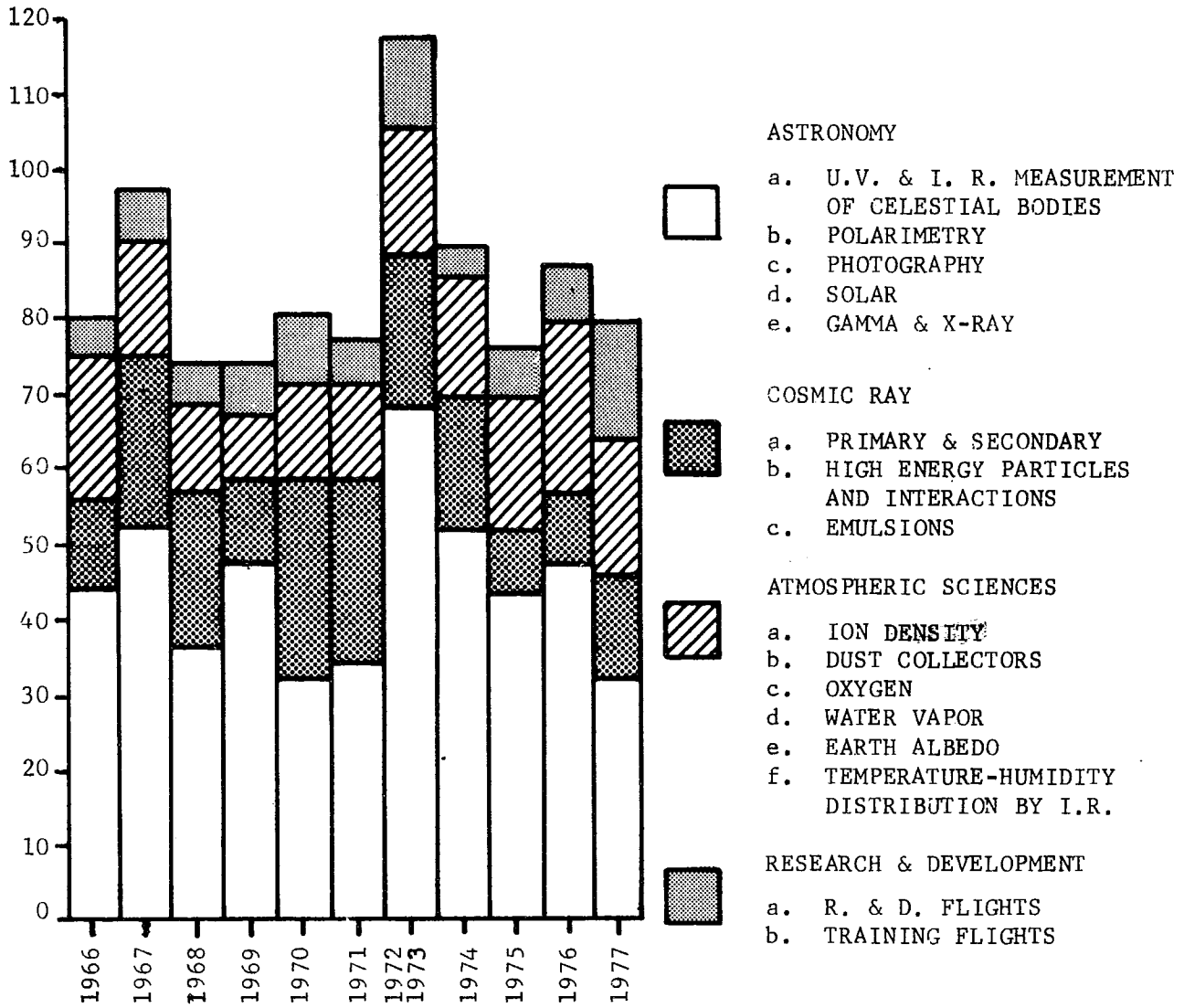

Figure 1. This chart shows how the NSBF balloon flight support has been distributed among the broad scientific disciplines.

YEAR	'66	'67	'68	'69	'70	'71	'72 '73	'74	'75	'76	'77
NUMBER OF FLIGHTS	81	98	74	74	81	77	118	86	76	86	80
FAILURES	30%	26%	19%	16%	15 %	19%	16 %	17.4%	11%	16.3%	11.2%
BALLOON	6%	16%	8%	9%	6%	14%	12%	11.6%	6.5%	9.3%	7.5%
ELECTRONICS	10%	2%	7%	3%	3%	3%	2%	0%	1.3%	2.3%	0%
OPERATIONAL	9%	3%	1%	1%	4%	3%	2%	5.8%	1.3%	4.7%	3.7%
WEATHER	5%	5%	3%	3%	2%	0%	0%	0%	0%	0%	0%
UNKNOWN	---	---	---	--	---	---	---	---	1.3%	---	---

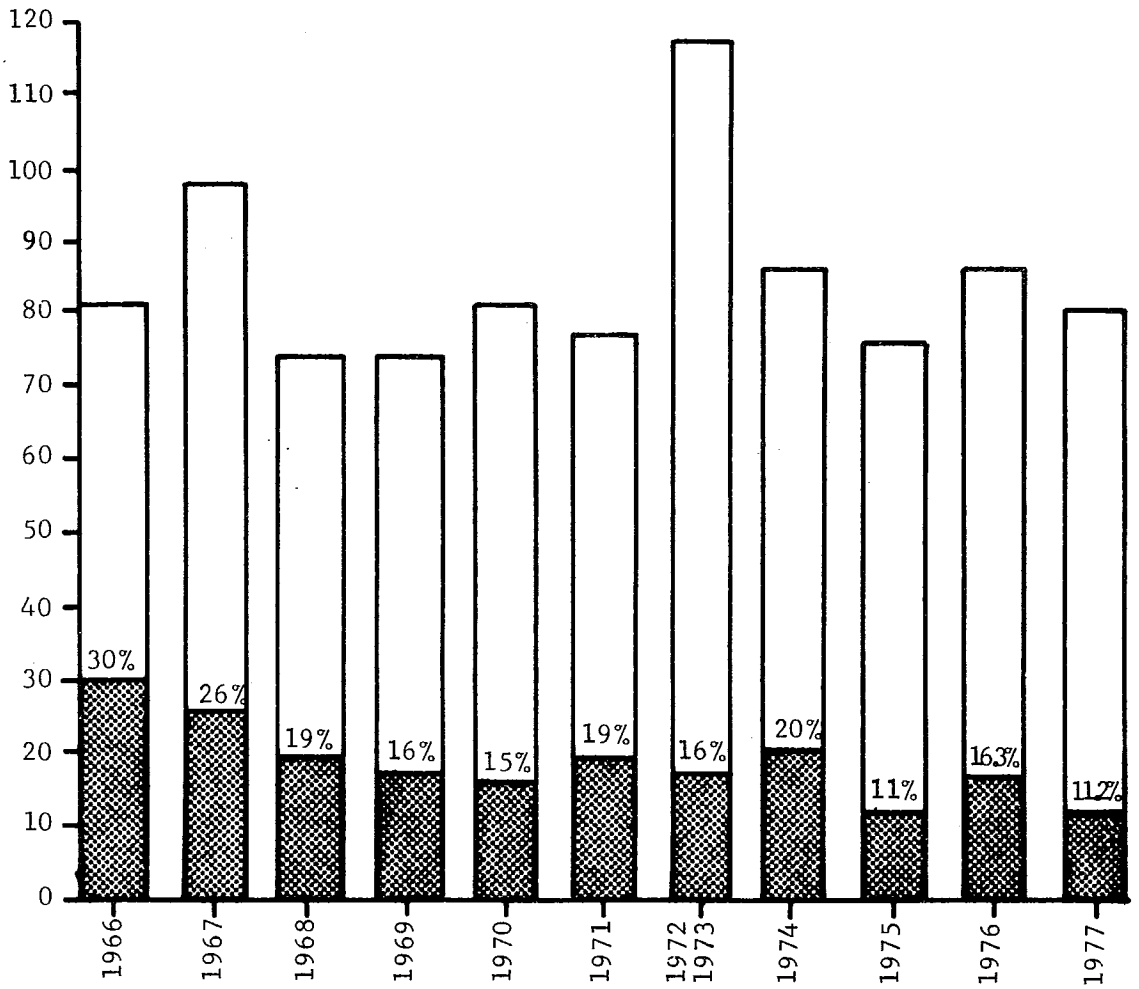

Figure 2. The number of flights attempted by the NSBF operations crew from all locations and the percentage frequency of failures are shown by years in both the graph and the table. The table also provides a breakdown by failure type.

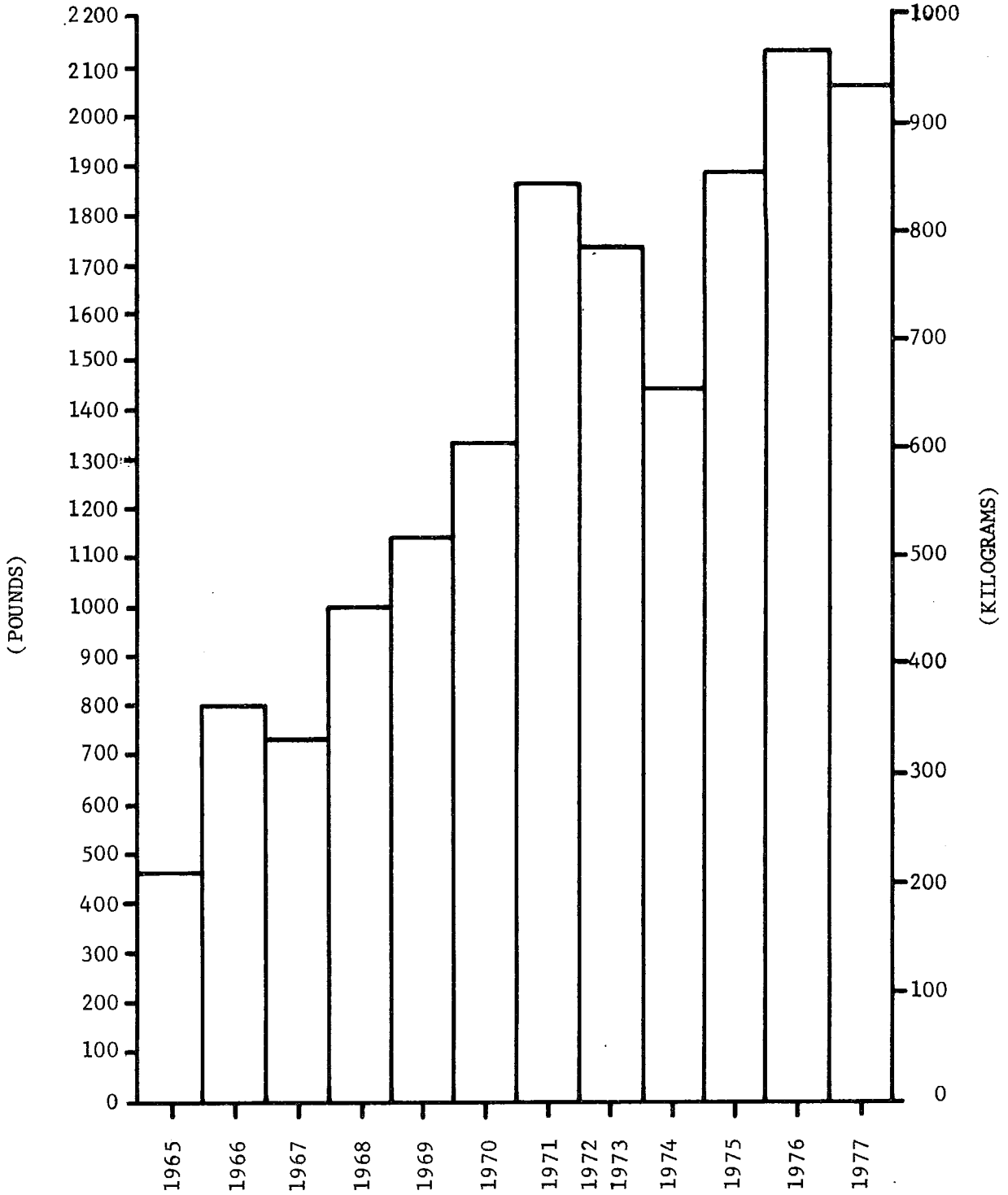

Figure 3. This graph shows the trend in average payload weight over the years.

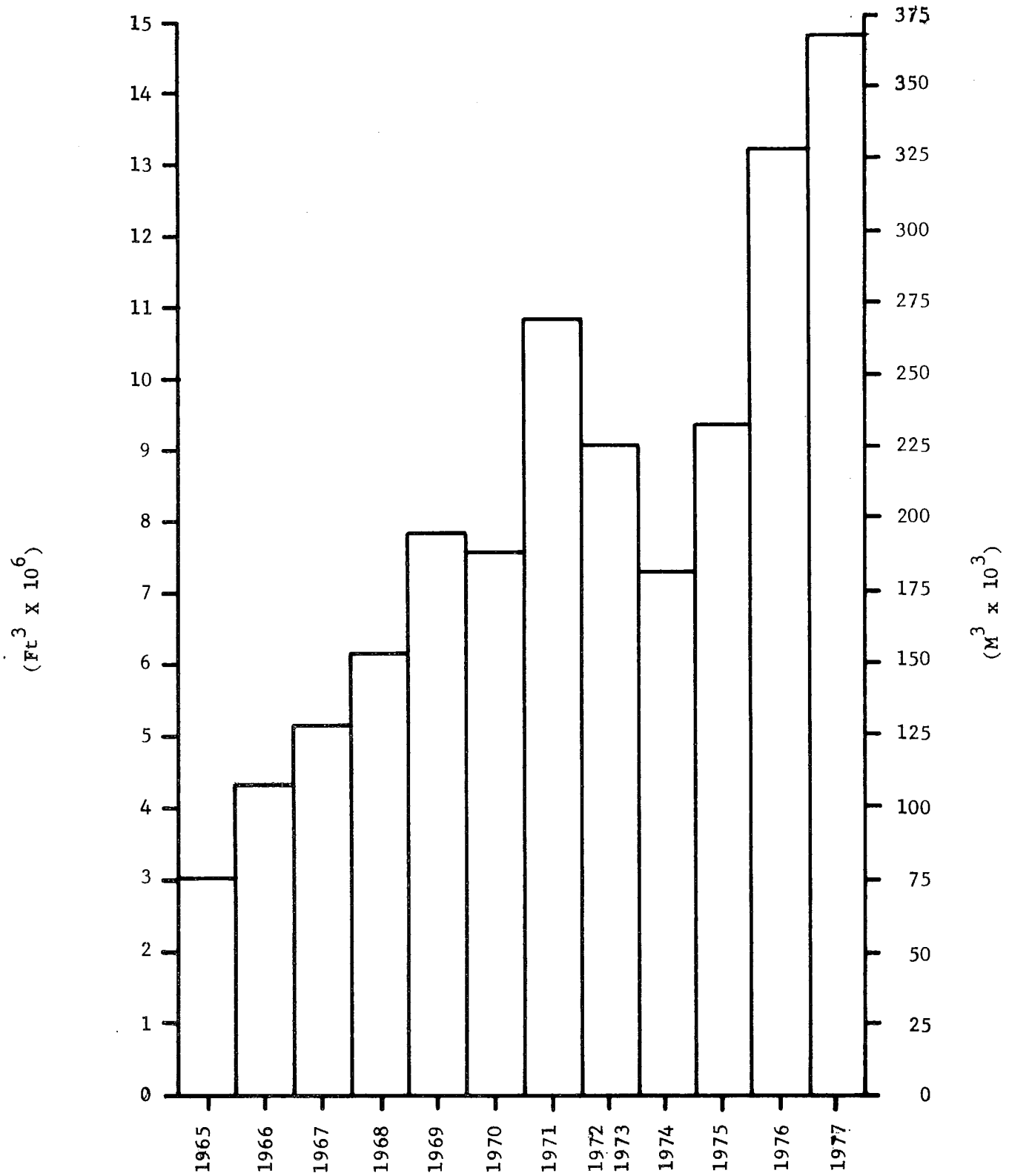

Figure 4. This graph shows the average balloon volume flown over the years.

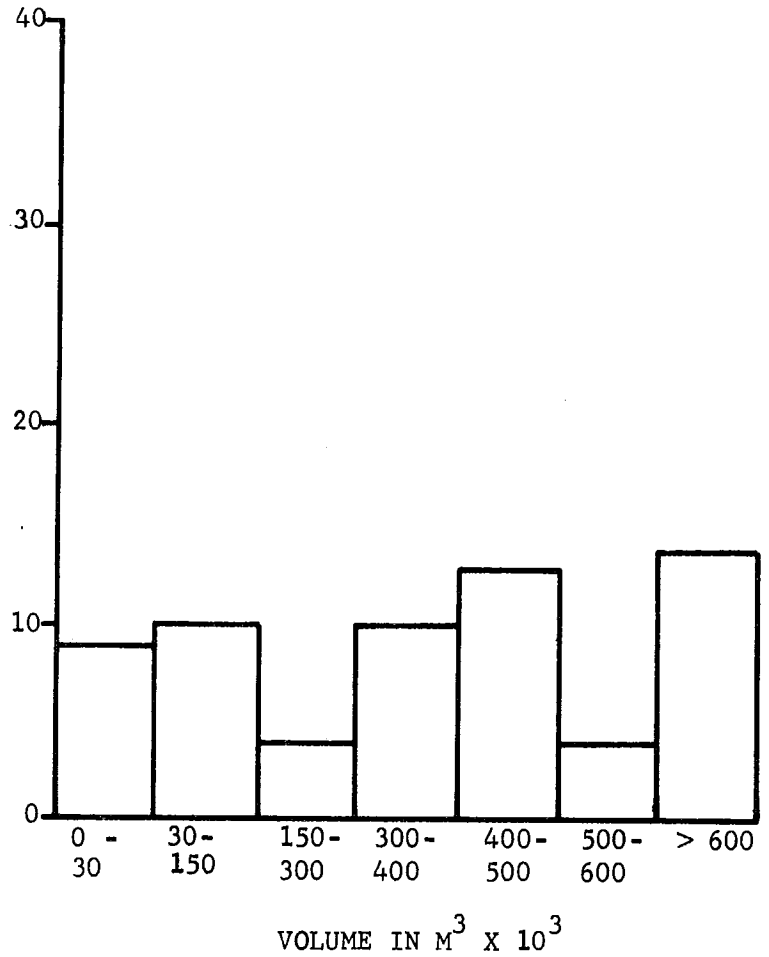

Figure 5. Balloon Volume Distribution for FY 1977 Flights

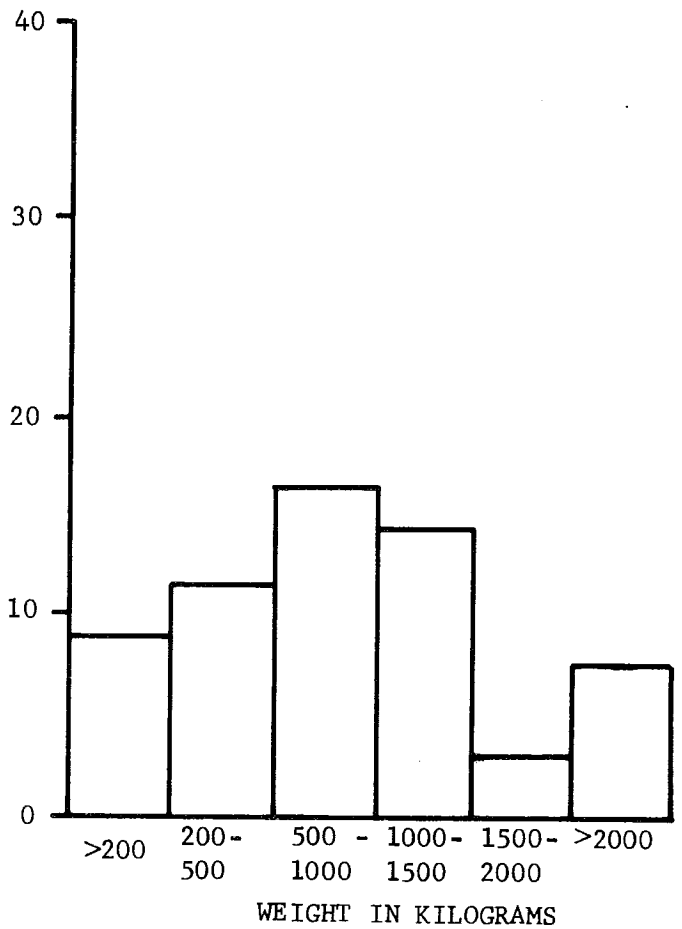

Figure 6. Payload Weight Distribution for FY 1977.

III. ENGINEERING DEVELOPMENT

The major effort of the engineering department continued to be directed toward long duration balloon development. This development is discussed, in detail, later in the report.

Increased attention is being devoted to the heavy load problem flights with a total suspended weight greater than 1,590 kg. The failure rate for these flights was 43% for 1976-1977 as compared with 25% for the previous three years, 1973, 1974 and 1975.

The heavy load failures can be divided into three categories, those occurring at float, those caused by launch dynamics and those caused by operating conditions at remote sites. The latter category has been discussed under the operations section of this report.

The possibility that the failures at float are connected with balloon design is being considered. Balloons are now designed for optimum performance with the minimum payload. They are normally flown with a payload in mid to upper range. In several of the failures at float, we have noted that the balloon exceeded maximum theoretical altitude shortly before failure.

Prof. J. Rand of Texas A & M University is investigating this problem from a theoretical standpoint. He has developed a model for balloon design incorporating more realistic assumptions than those currently in use. This will lead to more accurate load-altitude curves and possibly show questionable areas in balloon design. This program should be producing data in January 1978.

There is no question that the present dynamic launch system puts large stresses on the balloon bubble. We are investigating a system

that is essentially a tandem launch with a single cell balloon. The balloon will be tightly reefed with a soft collar for restraining the system. This collar can then be winched up to an angle between 45^{o} and 80^{o} and maneuvered to allow for any cross winds before release.

We are procuring material for construction of a restraining collar and plan to conduct model tests during FY 1978. Tests of a full-up system will depend on the availability of funds.

Texas A & M has continued to be a most useful extension of our own engineering effort. Beside the work of Rand mentioned above, they are doing all of our routine material testing. Prof. D. Webb has developed a U.V. test chamber that should give valuable information on degradation of material at altitude for long periods.

LONG DURATION DEVELOPMENT PROGRAM

(1) Vehicle Development

(a) Nylon-6 Study Program

Studies conducted by Raven Industries of the Nylon-6 film have been completed along with a final report. It was concluded from the study that the Nylon-6 film has poor creep characteristics due to water absorption and that, until this problem could be solved, the film could not be used successfully in a super pressure balloon.

(b) Sheldahl Kevlar Reinforced Polyester Film Study

The Sheldahl Flying Thread Loom (FTL) has been revised to enable the machine to run Kevlar yarns. The FTL will be used to produce a Kevlar reinforced polyester film for use in super pressure balloons. Runs using the reconfigured FTL were made using Dacron

to adjust yarn spacing and angles.

In late October and early November, 1976, a pilot run of the Kevlar reinforced polyester film was run by the FTL and allowed to cure. The film was then sent to Texas A & M University for testing and evaluation. It was found that the composite film was generally improved over the hand lay up samples previously tested. The yarns had a very good bond strength to the polyester film with much better and consistent ultimate material strengths. Some problems still exist in the micro structure such as individual yarn load transfer but the general strength of the material is good.

Once the test results were received, seal samples were made from the material to determine if a seal tape could be made that would transfer the load across the seam from gore to gore. Two different tape designs were used, one made from the parent material, the other from parent material with the machine direction yarn removed. Tests were conducted on the seals. It was found from the test results that the parent material seam tape was superior to the one with the machine direction yarn removed. Although the seal strength was close to the parent material strength at -30^{o} C, nearly all samples broke in the seal. This indicated a load transfer problem across the seam.

Progress has been slow in getting another run of material by Sheldahl due to some problems encountered with the use of Kevlar by Sheldahl for the HASPA Project. It was felt that until some basic revisions were made to correct the problem, it would not be

to our advantage to make another run of the material.

Four (4) 1.2 M diameter spheres were manufactured by Raven Industries for the NSBF using some of the LDP material. These four spheres have thermistors installed in them and will be flown along with unreinforced mylar spheres of the same size so that radiometric property data may be obtained for use in larger balloon systems utilizing the same material.

(c) Winzen Design and Nylon Development Study

Phase I, the preliminary design study, was completed during the previous years and reported in FY 1976 Annual Report.

In December 1976, a proposal was received for Phase II work with a contract being awarded in early February 1977. The purpose of the Phase II development program is to continue with work stemming from the initial contract. Work to be completed under Phase II is as follows:

1. Test model balloons of immediately available materials, Stratofilm® and aramid fiber net, checking computer stress analyses of line, tape and film performance and material characteristics such as abrasion, creep and modulas.
2. Materials review of data on aramid fiber lines and tapes with full scale redesign, and model test redesign resulting from the materials review.
3. Review the design, test and analysis as outlined previously with the NSBF.

4. A design and test analysis report written at the conclusion of the program.

Further discussions with WRI were held after the close of the initial contract and at the beginning of Phase II work. WRI has pursued an investigation of Nylon-12 for several years as a balloon film as it seemed to represent the best possible balloon film if a few properties, notably tear strength and low temperature characteristics could be improved. Working with a German chemical company, the only known source of this resin, proved to be very frustrating and non-productive. The company changed U. S. representatives several times and the resins were very inconsistent. Resins made for high volume applications, such as packaging, are simply not optimum for use in balloon films. It was suggested that WRI try to make their own resin in order to get the desired properties.

In March 1977, a proposal was received for Phase III with contract action initiated in that same month. Phase III work is to result in a usable Nylon-12 material for use in balloons. Several versions of Nylon-12 resin now available for other uses have not been made into film. WRI proposes to extrude film from them on a small scale to see what characteristics in the resin may improve the properties in question. There will be comprehensive testing of all properties under the contract. Based on the results of these tests, further runs will be made to optimize the resin for our needs. Each approach will then be extruded on a small scale by WRI and the same tests repeated. Since correlation

of properties of film extruded on a small scale is not necessarily the same as that made on that of production equipment, the most promising resins will then be extruded by WRI on production equipment. The films will then be tested and submitted for further evaluation by the NSBF if required.

Work has continued on both Phase II and Phase III of the study contract. Many tests on the Kevlar tapes and lines have been made in Phase II with some more tests being presently conducted to verify some of the earlier work. An interim report should be received shortly.

An interim report on Phase III, the development of a balloon grade Nylon-12 film was received in late July 1977. The report gave the method and test results of twenty-three different extrusion runs. Two or three combinations look promising, but more testing is required with the basic resins and extrusion variables before choosing the combinations to use in more refined testing.

d. Adhesive Grid Polyester Laminated Film

Testing has also started on the crack propagation characteristics of a bi-lamination of celanar utilizing an adhesive grid pattern. Two different sized equilateral triangle patterns will be tested against a control sample to determine if there is an improvement in the film's crack resistance. This data can then be used in the development of possible future films. Preliminary results indicate there is no ultimate strength loss of the material by using less adhesive. The crack propagation studies are still underway to determine which of the grid patterns is better.

e. Associated Programs

Data Reduction - Work was started on developing the capability of complete reduction of test flight data utilizing the NCAR 7600 computer. The computer program GENPROC is being reconfigured to allow the processing of flight data into a more useful form utilizing graphical representation.

All test flight data has been plotted by hand with results showing that slight revisions in existing thermodynamic modelling of balloons is required to more accurately predict balloon behavior. Work is presently being conducted to revise some of the theory to agree with actual flight data.

Sensitivity studies were conducted in regard to the Sky Anchor Balloon System, for the average environment case. Optimization curves have been obtained for these conditions with future work to be carried out concerning the extreme environment once more data has been obtained.

With the success of the Sky Anchor II balloon system a great deal of system behavior data was obtained which showed a need for small changes in the present Sky Anchor system model. One very important problem that needed to be solved was the determination of an accurate float altitude of the zero pressure balloon. From a study of previous zero pressure flights it became obvious that approximately ninety percent, 90%, of the zero pressure balloons failed to reach the manufacturer's theoretical float altitude. In fact, most floated between 300 to 600 M below the theoretical altitude. This is often satisfactory for normal flights, but due to Sky Anchor

requirements the float altitude must be predicted accurately in order to obtain the necessary ballast effect.

A study has been started to more accurately determine the balloon shape and volume thus resulting in a refined load altitude curve. Further work will also be done in regard to local atmospheric conditions which may affect the load altitude curve.

Through the various test flights several changes have been made in the Sky Anchor System. Some of these have been the fabrication of a low profile super pressure launch spool to prevent the tether line from snagging on it. Pi-balls have been attached to the connecting tether line to pick the line off the ground thus eliminating the need for one of the two tether line handlers. The super pressure instrumentation package has been relocated to the base of the super pressure along with some ballast to help "string" the balloon out to prevent "sailing" and to eliminate some electrical problems. These and several other improvements in the system have been made to improve the reliability of the system.

(2) Test Flights

a. Radiometric Flights

Preliminary data reduction has been completed on two (2) 14,150 M^3 polyethylene balloons which were flown in June and August. The first flight which was at night over severe weather conditions resulted in a wealth of radiometric information on balloon behavior, materials properties, and convectional models. An identical flight was conducted over clear nighttime conditions and data compared with the cloudy nighttime conditions. Results

from these flights will be compared with data from other flights. It has been found that the convection cells inside the balloon differ greatly at different altitudes. Data from all of these flights can then be used to predict the behavior of both super pressure and zero pressure balloons for various altitudes and radiation environments.

b. October 1976 - 38.89 M Sphere Flight

A test flight was conducted utilizing a 38.89 M super pressure sphere to determine the ultimate manufactured strength of the balloon utilizing design changes in fitting reinforcements and locations.

The balloon was launched at 0730:00 CDT from Palestine, Texas on 14 October 1976. The balloon arrived at its initial float altitude of 15.0 Mbs with a suspended load of 295 kgs. The balloon was then slowly pressurized to a skin stress of approximately 9500 psi and allowed to float at 13.3 Mbs and a suspended load of 228 kgs for two hours. Plans called for allowing the balloon to float through the night and to pressurize it to failure the next day, but due to unpredictable upper level winds, the balloon started heading towards the Gulf of Mexico. It was then decided to pressurize the balloon to failure that afternoon, with failure occurring at a skin stress of approximately 11,500 psi.

From an operational stress standpoint the sphere would have survived the most extreme nighttime environment that a balloon should encounter on a long duration mission. It is felt that if final pressurization could have been at a slower rate, the failure

strength would have been even greater.

c. Flight 999-PT - Test Flight

A test flight was conducted in November 1976 utilizing an 84,963 M^3 zero pressure balloon built by Raven Industries. The purpose of the flight was the testing of a liquid ballast system to be used on the future Sky Anchor flights and the testing of thermodynamic properties of a new flameproof insulating material for use in scientific gondolas. The test was successful in both efforts with temperature data being recorded for various insulating configurations.

d. Sky Anchor Test Launch

In December 1976 a test launch of the Sky Anchor system was made to familiarize everyone with the launch procedure and to detect any problem areas that may be encountered during a full up flight launch. The launch consisted of a 113,300 M^3 main balloon, a 47,151 M^3 balloon simulating the ballast sphere, and a 114 M^3 tow balloon. The layout and inflation were conducted just as would be in an actual flight. The balloons were then launched and after the system had ascended several kilometers the tow balloon was cut away and destructed. The entire system was then terminated.

The test was very successful. There were no high loadings introduced into the system.

e. January 1977 Sky Anchor I Test Flight

In January 1977, the test flight of Sky Anchor I was conducted from Page, Arizona. The system consisted of a 117,091 M^3

zero pressure balloon, a 245 kg payload, and 35,483 M^3 super pressure. The launch and initial ascent went as expected except for a slightly higher ascent rate than desired. The reefing system had started to deploy properly and at approximately 10 km visual sighting was lost due to clouds. At approximately 16 km a sudden drop in altitude was registered. The system then continued to ascend to float altitude. After obtaining several visual sightings verifying that the super pressure had failed, the flight was terminated in Colorado. Down cameras revealed that the reefing sleeve slit all the way down the balloon thus allowing the sphere to open up into a gigantic sail. At this altitude a small shear was encountered which, due to the sailing balloon, probably caused severe loading and the failure.

f. Flight 1009-PT

In April a test flight was conducted utilizing an 84,953 M^3 zero pressure balloon. The purpose of the flight was to check out live television coverage from the payload for use in real time visual observation in later balloon flights. Nighttime radiometric properties were obtained on the new flame resistant insulation to be used in the future.

g. Sky Anchor II Test Flight

In May 1977, the test flight of Sky Anchor II was conducted from Palestine, Texas. The system consisted of a 14,160 M^3 zero pressure balloon, a 145 kg payload, and a 5,132 M^3 super pressure balloon. Instrumentation included altitude monitoring, two (2) super 8 mm surveillance cameras, one (1) super pressure strain

gauge, and one television camera on the main package for live on-board coverage of the balloon system and cloud cover.

The launch and ascent were as expected with an average ascent rate of 150 meters/second. The balloon system achieved a float altitude of 28.6 km. The system was allowed to float for 47 hours, through two nights, without ballasting, before being terminated with the package being recovered in excellent condition. The flight was very successful thus making it the largest system of its kind ever to have successfully flown.

h. Sky Anchor III Test Flight

In June 1977, the test flight of Sky Anchor III was conducted from Grenada, Mississippi. The remote site was chosen due to the high winds at the float altitude which would not allow sufficient float time from Palestine. The balloon system consisted of a 117,091 M^3 zero pressure balloon, a 233 kg payload and a 35,483 M^3 super pressure balloon.

The launch of the system went smoothly. However, when the tow balloon, above the superpressure balloon, was cut away at approximately 1 km the ascent stopped. Ballast was then dropped to aid the ascent. The pilot reported a large hole in the wall of the super pressure balloon. The flight was then terminated when the balloon system was over a satisfactory recovery zone. Investigations revealed that when the tow balloon was cut away, the primer cord destruct was activated thus destroying the super pressure balloon. Investigation was made of the failure and steps were taken to prevent further similar occurrence.

Instrumentation included two (2) super 8 mm movie cameras, a load cell, altitude monitors, differential pressure gauge, and a television camera for real time visual monitoring of the system.

i. Sky Anchor IV Test Flight

In September 1977, a test flight from Palestine, Texas, of another small Sky Anchor balloon system was attempted utilizing a 14,160 M^3 zero pressure balloon, a 157 kg payload, and a 5,132 M^3 super pressure balloon. The purpose of the flight was to provide more launch experience for the launch crews and to obtain more system dynamic behavior to verify changes in the Sky Anchor models. Instrumentation included altitude monitoring, two (2) super 8 mm surveillance cameras, one (1) super pressure strain gauge, one (1) television camera, and one (1) Satellite Transit Receiver for position.

The layout and inflation of the balloons went very smoothly. A wind direction change occurred approximately 10 minutes prior to launch which, when the main balloon was launched, the cross wind carried the payload and tether in a direction different from what the system was laid out for. The tether line then snagged on the corner of the super pressure spool trailer which was protruding several feet out. The flight was then terminated.

(3) Electronics Development

The second half of 1976 was occupied by the preparation of system specifications for use of the Marisat satellites for a balloon data link. This effort was being undertaken on the basis of a report pre-

pared by Satellite Systems Engineering, a Washington, D. C. consulting firm. The report, completed in April 1976, had indicated that all arrangements for our use of the system could be made and then an acceptable price could likely be negotiated with Comsat General.

Efforts to establish a firm agreement with Comsat General were delayed several months by their contracts office. During this period, the detailed system specification was prepared but the request for proposals was not issued because of the uncertainity about the arrangements.

Finally in January 1977, a firm quote for services was obtained from Comsat General. The cost to implement our system was considerably higher than expected. An expenditure of $1.3 million would be required to proceed through the first operational series of flights. Follow-on costs were also excessive and were not in line with expected funding levels.

It was therefore decided that an alternative solution would have to be considered. This was necessary because our development funds are limited and we could not afford to expend them on development of a system which would not be funded for operation.

Several alternatives were considered but a compromise solution was finally adopted. It consists of a long range commitment to the Tracking and Data Relay Satellite System (TDRSS) and an interim plan for use of the SMS/GOES satellites for support of test flights and scientific flights with limited data requirements.

The TDRSS is scheduled to be operational in 1980 and will exceed our requirements for support in all areas. Discussions with the TDRSS program office were held to establish the ground rules for our use of

the system. We were assured that our program could be supported without problem through 1985 and that with consideration for scheduling restraints, it could continue indefinitely. This service would involve no charge to the NSBF or the scientific investigator.

The major portion of our development funds will be used to implement the TDRSS capability over the next two years. A minor part is presently being used to implement an interim program utilizing the SMS/GOES system.

Approval was obtained in May from the National Environmental Satellite Service (NESS) for NSBF use of SMS/GOES satellites to relay data from balloons which are orbiting the earth in the southern hemisphere. This relay will allow transmission at 100 bits-per-second during approximately 60% of an orbit.

Two GOES data transmit terminals have been purchased from Handar and are currently undergoing tests prior to their initial test flight. These units transmit at 10 watts for five minutes per hour. Greater time periods can be easily implemented if approval from NESS is obtained and the necessary on-board power can be provided. NESS has indicated that such approval is very likely if adequate notice is given and the scheduled use is flexible.

Solar cell panels have been ordered and are scheduled for delivery in December. These panels will be configured into an array which can provide 47 volts output with a peak current of 1.6 amps. This array will power the satellite platform and the associated equipment including a Transit Satellite receiver for navigation, a PCM data encoder and special interface and control circuitry. A similar independent power

system will be provided for experimenter requirements. Both systems utilize rechargeable batteries for night operation.

This equipment is currently being configured into a flight package for support of upcoming test flights and operational flights with limited data requirements.

Data transmitted to the GOES satellites is relayed to the World Weather Building via the receiving station at Wallops Station, Virginia. From there it is disseminated to the NSBF in Palestine over commercial phone lines. A Texas Instruments 742 data terminal has been installed to communicate with the GOES data processing center and to accept the data messages. Data tapes generated by this terminal will then be dumped into the PDP-11 computer for processing.

FY 1978 should produce an operational SMS/GOES capability and a system specification for TDRSS hardware.

IV. ADMINISTRATION

PERSONNEL

The staff of the National Scientific Balloon Facility on 30 September 1976 (the end of the Transition Quarter) and on 30 September 1977 (the end of FY 1977) consisted of forty-seven (47) full-time positions and one (1) part-time employee. The regular full-time staff allowance is classified as follows:

Administration	- 5
Clerical	- 4
Engineers	- 5
Guards	- 4½
Machinist	- 1
Maintenance	- 1
Mechanic	- 1
Pilots	- 2
Support Scientists	- 2
Technicians	- 22
TOTAL	47½

Staff changes for the Transition Quarter and FY 1977 were as follows:

1. 22 July 1976 - Ricky Smothermon was hired as a temporary Balloon Technician.
2. 22 July 1976 - Michael Gibson was hired as a temporary Balloon Technician.
3. 1 August 1976 - Robert Perrin was hired as an Electronics Technician.
4. 10 September 1976 - Ricky Smothermon completed his job as a temporary Balloon Technician.

5. 10 September 1976 - Michael Gibson completed his job as a temporary Balloon Technician.

6. 1 October 1976 - Judy Kay Stevens was hired as a Casual Clerk-Typist.

7. 18 October 1976 - Mackie Cox was hired as a Casual Clerk-Typist.

8. 14 November 1976 - Ferrell Davis was hired as a Casual Security Guard.

9. 1 March 1977 - Vincent Blanton was hired as a temporary Balloon Technician.

10. 1 March 1977 - Harold Dean was hired as a temporary Balloon Technician.

11. 1 March 1977 - Barry Williams was hired as a temporary Balloon Technician.

12. 28 March 1977 - William Schumacher was hired as an Electronics Technician.

13. 28 March 1977 - Titus Sigler was hired as an Electronics Technician.

14. 14 May 1977 - Fidel Trujillo, Jr., was hired as a summer Student Visitor

15. 14 May 1977 - Curtis Symank was hired as a summer Student Visitor.

16. 31 May 1977 - Barry Williams completed his job as a temporary Balloon Technician.

17. 10 June 1977 - Vincent Blanton completed his job as a temporary Balloon Technician.

18. 1 July 1977 - Fidel Trujillo, Jr., completed his job as a summer Student Visitor.

19. 13 July 1977 - Judy Kay Stevens resigned as a Casual Clerk-Typist.

20. 21 July 1977 - Troylnn Wiggins resigned as Engineering Technician Trainee.

21. 24 August 1977 - Kevin Kennedy was hired as a temporary Balloon Technician.

22. 24 August 1977 - Delwyn Sims was hired as a temporary Balloon Technician.

23. 24 August 1977 - Charles Johnson was hired as a temporary Balloon Technician.

24. 26 August 1977 - Ferrell Davis resigned as a Casual Security Guard.

25. 30 August 1977 - Curtis Symank completed his job as a summer Student Visitor.

26. 23 September 1977 - Charles Johnson resigned as a tempoary Balloon Technician.

27. 30 September 1977 - Harold Dean completed his job as a temporary Balloon Technician.

FUNDING

Transition Quarter (July, August and September 1976) funding was $300,000. The NSBF also received $27,000 from NASA for Engineering Research and Development during the Transition Quarter.

Continuing Programs funding in FY 1977 was $1,271,000, an increase of $102,000 over FY 1976. Additionally, $108,000 was received from

NASA for Engineering Research and Development.

The Transition Quarter and the FY 1977 Budget for the NSBF is broken down as follows:

TRANSITION QUARTER FUNDING

	SALARIES BENEFITS & TRAVEL	SUPPLIES SERVICES & EQUIPMENT	TOTALS
1. Administration	$ 56,269	$ 22,500	$ 78,769
2. Engineering	15,718	1,000	16,718
3. Operations	147,170	57,343	204,513
TOTALS	$219,157	$ 80,843	$ 300,000

FY 1977 FUNDING

	SALARIES BENEFITS & TRAVEL	SUPPLIES SERVICES & EQUIPMENT	TOTALS
1. Administration	$236,638	$ 92,600	$ 329,238
2. Engineering	67,433	2,500	69,933
3. Operations	583,295	288,534	871,829
TOTALS	$887,366	$383,634	$1,271,000

PANEL MEETINGS

Two meetings of the NSBF Advisory Panel were held during the year. In addition, one meeting of the Operations Sub-Committee was held.

The fall meeting of the Panel was held on 16 November 1976, at the NSBF. The major items of discussion were the Policy Statement on Use of the NSBF, the National Academy Study on the Use of Balloons for Physics and Astronomy, status of the Australian Balloon Launch Station, the Trans-Atlantic Program and the Long Duration Development Program.

The spring meeting was held at NCAR on 28 February 1977. The major items of discussion were the Long Duration Development Program, the anticipated increase in remote flights, the anticipated budget shortage in FY 1978 and the Australian Balloon Launch Station.

The Operations Sub-Committee met at the NSBF on 18 October 1976 and reported to the Panel at the fall meeting. The Sub-Committee reported that there were no outstanding weaknesses, and consequently no urgent recommendations for changes.

Members of the Panel during FY 1977 were as follows:

	Dr. R. Chasson, University of Denver	Term expired in Fall 1976
*	Dr. G. Fazio, Smithsonian Institute	Term expires in Fall 1979
+	Dr. D. Kniffen, NASA - Goddard Space Flight Center	Term expires in Fall 1979
+	Dr. R. Golden, NASA - Johnson Space Center	Term expires in Fall 1977
***	Dr. R. Gordon, Rice University	Term expires in Fall 1977
	Dr. W. Lewin, Massachusetts Institute of Technology	Term expires in Fall 1978
** +	Dr. D. Mueller, University of Chicago	Term expires in Fall 1978
	Dr. D. Murcray, University of Denver	Term expires in Fall 1977
	Dr. M. Pelling, University of California, San Diego	Term expires in Fall 1978

*Chairman through Fall Meeting

**Elected Chairman at Fall Meeting

***UCAR Trustee Representative

+Sub-Committee Member

V. BASE DEVELOPMENT

Staging Building - A contract was signed on 27 September 1976 with Lockwood, Greene Engineers, Inc., of Dallas, Texas for architectural and engineering services. Final design was approved on March 18, 1977.

Request for bids were issued with the bid opening taking place at the NSBF on 12 May 1977. Howard U. Freeman, Inc., Irving, Texas was low bidder. The construction contract was signed with Freeman on 18 July 1977. Completion is scheduled for February 1978, at a cost of approximately $460 K.

The building will contain two double staging bays, each approximately 84 M^2 for a total staging area of 336 M^2. This is the equivalent of four (4) Stratoports. Doors to the bays are 9.1 M high. Each bay will have a 2,272 Kg traveling crane with a hook height of 10.7 M.

The two bays will connect through a control section four stories high, each 84 M^2. The first floor will contain the utilities and a lounge. The second floor is planned for use as an electronics shop. The third floor will contain the telemetry and computing facilities. The fourth floor will be the control tower topped by an antenna platform. The floors will be connected by elevator and stairs.

Vargo Building - It is planned to convert the Vargo Building (adjacent to the Tim shelter) into a test laboratory. Much of the routine film testing would then be transferred from Texas A & M University to the NSBF. Work has started on this conversion and should be completed in the spring of 1978. The laboratory should be operational by early 1979.

Security System - In order to limit access to the NSBF, a new guard station and gate has been installed on the access road into the base. The gate is card-activated so that the staff and visiting scientists may have access when the guard is making security checks. An additional gate will be installed across the highway when the staging building is completed.

Rigging Bay - A covered concrete pad has been added to the rigging bay to facilitate stretching and rigging of parachutes.

Phone System - A GTD-120 Digital PABX phone system has been installed. This system is a great improvement in flexibility and efficiency over the old system.

VI. PLANS FOR FY 1978

The NSBF will continue to offer operational and engineering support to all authorized scientific groups. We anticipate a total of 75 to 85 flights during the year. Two remote expeditions are planned, one to the northern U. S. and one to central U. S. We will continue to provide limited support to U. S. scientists flying from Australia.

There is considerable interest within the European scientific community for additional Trans-Atlantic flights. Our involvement in these flights depends on U. S. scientific participation and is yet undefined. We also have several requests for equatorial flights and will try to accommodate these requests if possible.

The new staging building should be ready for occupancy in February, 1978. This additional space will be a great help during the crowded turn-around periods.

The Long Duration Vehicle development should be completed during FY 1978. Two test flights are planned. A proven system capable of carrying a gross load of 227 Kg to 40.5 mb will be proven and available. We will continue development on this system in order to optimize performance and scale up to heavier payloads.

The command and telemetry package for use with the SMS-GOES satellite will be test flown in FY 1978. We will end the year with two operational systems.

The specifications for the TDRSS airborne package will be completed leading to a development contract late in the year. This will also provide for our prototype package.

We will continue our effort on the heavy load problem. The rate of progress on this problem will depend on the availability of funds.

APPENDIX A

SUMMARY OF FLIGHTS

FLIGHT NUMBER	DATE	EXPERIMENTER & ORGANIZATION	TYPE OF EXPERIMENT	BALLOON VOLUME (M^3)	GAUGE & MATERIAL	MANUFACTURER	PAYLOAD WEIGHT (KGS)	FLOAT TIME (HRS)	PRESSURE FLOAT ALT. (MB)	FLIGHT SUCCESS
975-P	6 July 1976	Dr. K. de Boer Univ. of Groningen	Far infrared telescope	392,213	12.70 μ Poly	Winzen	1007.9	6.6	5.0	Success
976-P	7 July	Dr. F. Low Univ. of Arizona	Low background far infrared telescope	14,160	25.00 μ Poly	Raven	254.6	10.7	18.0	Success
977-P	28 July	Dr. J. Anderson, Univ. of Michigan/ J. Stanley, NASA/JSC	Atmospheric sciences	434,934	12.70 μ Poly	Winzen	385.6	1.0	1.85	Success
978-P	4 August	Drs. M. Campbell/ W. F. Hoffmann Univ. of Arizona	Far infrared survey at 20, 50 and 100 microns	87,672	30.48 μ Poly	Winzen	908.2	6.3	11.0	Success
979-PT	11 August	S. Smith NSBF/Engineering	Test Flight	14,160	19.00 μ Poly	Raven	160.6	11.8	13.0	Success
980-PT	25 August	S. Smith, J. Ingram NSBF	Test and training flight	N/A	N/A	N/A.	N/A	N/A	N/A	Success
981-P	31 August	Dr. J. Benbrook Univ. of Houston	Propagation of electromagnetic radiation from lightning	87,672	17.78 μ Poly	Winzen	132.0	11.9	3.57	Success
982-P	3 September	Dr. R. Weiss/ D. Muehlner, M.I.T.	Cosmic background radiation study	329,213	12.70 μ Poly	Winzen	543.8	8.3	2.90	Success
983-PT	8 September	S. Smith/J. Ingram NSBF	Test and training flight	N/A	N/A	N/A	N/A	N/A	N/A	Success
984-P	15 September	Drs. R. Weiss/ D. Muehlner, M.I.T.	I-R survey of large dust clouds	157,346	12.70 μ Poly	Winzen	436.4	10.6	3.80	Success
985-P	16 September	Drs. Y. Kondo, NASA JSC/C. de Jager, The Netherlands	Spectrophometry in spectral regions from 2000 Å to 3400 Å	600,000	15.00 μ Poly	Raven	932.5	11.1	2.73	Success
986-P	23 September	Drs. J. Nishimura, Univ. of Tokyo/ J. J. Lord, Univ. of Washington	High energy cosmic ray study	314,319	19.05 μ Poly	Raven	669.9	26.0	3.25	Success
987-P	24 September	Dr. J. Downing JPL	Measurement of solar spectral distribution between 0.38 and 1.1 microns	438,320	12.70 μ Poly	Winzen	193.3	0.3	1.50	Balloon Failure
988-P	29 September	Drs. J. Kurfess/ W. Johnson-NRL	X-ray survey	436,260	12.70 μ Poly	Winzen	792.0	27.3	2.51	Success
989-P	30 September	Dr. R. Golden NASA-JSC	Cosmic ray detector	860,561	22.86 μ Poly	Winzen	3124.0	N/A	N/A	Balloon Failure

SUMMARY OF FLIGHTS

FLIGHT NUMBER	DATE	EXPERIMENTER & ORGANIZATION	TYPE OF EXPERIMENT	BALLOON VOLUME (M^3)	GAUGE & MATERIAL	MANUFACTURER	PAYLOAD WEIGHT (KGS)	FLOAT TIME (HRS)	PRESSURE FLOAT ALT. (MB)	FLIGHT SUCCESS
990-P	2 October	Dr. J. Anderson Univ. of Michigan	Stratospheric measurement program	434,934	12.70 μ Poly	Winzen	445.9	1.3	1.86	Success
991-P	4 October	Dr. G. Frye CWRU	Gamma ray observations in energy range above 10 MeV	1,069,926	10.16 μ Poly	Winzen	904.9	13.5	1.55	Success
992-P	11 October	Dr. J. Ormes GSFC	Cosmic ray experiment	698,361	22.86 μ Poly	Winzen	3459.7	28.0	6.4	Success
993-P	13 October	Dr. J. Strong Univ. of Maryland	Study of solar corona in near infrared	87,672	30.48 μ Poly	Winzen	676.9	5.2	9.40	Success
994-PT	14 October	S. Smith NSBF-Engineering	Engineering test flight	30,800	19 x 19 Bilam Celanar	Raven	.322.0	6.0	12.88	Success
995-P	20 October	Dr. K. de Boer Univ. of Groningen	Far infrared telescope	314,319	19.05 μ Poly	Raven	1031.0	7.0	4.5	Success
996-P	21 October	Drs. R. Jennings, and W. Towlson, Univ. College, London A. Moorwood/ESTEC	Infrared telescope to survey galactic and extra galactic regions	119,266	20.32 μ Poly	Winzen	1134.4	3.0	9.6	Operations Failure
997-P	10 November	Drs. F. Fuligni/ D. Brini- TESRE, CNR	Cosmic x-ray background in 10 - 200 kev range	329,213	17.78 μ Poly	Winzen	558.5	2.5	3.15	Success
998-P	29 November	Dr. R. Joseph Imperial College	Infrared telescope	122,334	25.40 μ Poly	Winzen	1356.0	10.2	11.0	Success
999-PT	2 December	J. Ingram NSBF	Test and training flight	84,951	19.05 μ Poly	Raven	269.4	2.6	4.85	Success
1000-P	3 December	Dr. R. Downing JPL	Calibration of solar cells	65,267	17.78 μ Poly	Winzen	168.3	3.0	4.85	Success
1001-P	6 December	Dr. J. Anderson Univ. of Michigan/ J. Stanley-NASA/JSC	Stratospheric measurement program	434,934	12.70 μ Poly	Winzen	449.9	1.5	2.05	Success
1002-PT	16 December	S. Smith NSBF	Sky Anchor test	113,300	13.00 μ Poly	Raven	167.9	N/A	N/A	Success
1003-P	16 December	Dr. R. Joseph Imperial College	Infrared telescope	122,234	25.40 μ Poly	Winzen	1408.0	5.4	12.0	Success
1004-PT	11 January 1977	Dr. O. Cooper NSBF	Test of radar reflective tapes and transponders	2,832	13.00 μ Poly	Raven	21.7	0.5	11.0	Success
1005-PT	11 January	Dr. O. Cooper NSBF	Test of radar reflective tapes and transponders	2,832	13.00 μ Poly	Raven	21.7	0.5	11.0	Success

SUMMARY OF FLIGHTS

FLIGHT NUMBER	DATE	EXPERIMENTER & ORGANIZATION	TYPE OF EXPERIMENT	BALLOON VOLUME (M^3)	GAUGE & MATERIAL	MANUFACTURER	PAYLOAD WEIGHT (KGS)	FLOAT TIME (HRS)	PRESSURE FLOAT ALT. (MB)	FLIGHT SUCCESS
1006-P	16 February	Dr. D. Wilkinson Princeton Univ.	Cosmic microwave background radiation	14,160	25.00 μ Poly	Raven	288.0	12.2	23.7	Success
1007-P	28 February	Dr. M. Pelling Univ. of California San Diego	High energy x-ray from Crab Nebula	580,498	12.70 μ Poly	Winzen	1038.3	4.5	2.75	Success
1008-P	8 March	Drs. S. Scott, N. Farlow/J. Vedder NASA-Ames Research Center	Stratospheric aerosols and trace gases	314,350	25.40 μ Poly	Raven	1054.7	3.3	5.1	Success
1009-PT	5 April	J. Lehmann NSBF	Thermal studies	84,950	19.05 μ Poly	Raven	224.4	6.0	4.85	Success
1010-P	6 April	Dr. J. Anderson, Univ. of Michigan J. Stanley, NASA/JSC	Stratospheric measurement program	434,934	12.70 μ Poly	Winzen	440.0	1.1	2.09	Success
1011-P	18 April	Dr. W. Schlosser Ruhr University	Photographic studies in spectral region 2300 Å to 2900 Å	175,000	13.00 μ Poly	Raven	359.7	4.5	3.2	Success
1012-P	22 April	Dr. P. Marsden Univ. of Leeds	Cosmic ray experiment	437,341	12.70 μ Poly	Winzen	1164.0	6.3	3.70	Success
1013-P	25 April	Dr. G. Fazio Center for Astro-physics	Infrared mapping	160,179	25.40 μ Poly	Winzen	2236.1	9.0	14.0	Success
1014-P	26 April	Drs. E. Maier, A. Aikin/J. Ainsworth NASA-GSFC	Stratospheric composition	437,341	12.70 μ Poly	Winzen	1050.8	.9	3.30	Success
1015-P	26 April	Dr. J. Anderson Univ. of Michigan/ J. Stanley/NASA-JSC	Stratospheric measurement program	727,514	12.70 μ Poly	Winzen	751.2	.7	1.97	Success
1016-P	3 May	Drs. P. Richards D. Woody/J.McBride Univ. of California Berkeley	Measurement of sub-millimeter cosmic background	896,241	12.70 μ Poly	Winzen	693.1	2.5	1.82	Success
1017-P	11 May	Drs. J. Fishman/ C. Meegan-MSFC	Use of sodium iodide scintillation counters to detect bursting and periodic x-ray sources in the 30 Kev to 500 Kev energy range	437,341	12.70 μ Poly	Winzen	875.7	14.8	2.85	Success
1018-P	22 May	Drs. A. Dean, Univ. of Southampton/ G. Villa, Univ. of Milan, Italy	Low energy x-ray	628,704	20.32 μ Poly	Winzen	2805.0	30.5	5.52	Success

SUMMARY OF FLIGHTS

FLIGHT NUMBER	DATE	EXPERIMENTER & ORGANIZATION	TYPE OF EXPERIMENT	BALLOON VOLUME (M^3)	GAUGE & MATERIAL	MANUFACTURER	PAYLOAD WEIGHT (KGS)	FLOAT TIME (HRS)	PRESSURE FLOAT ALT. (MB)	FLIGHT SUCCESS
1019-PT	23 May	Mr. K. Lamb SED Systems, Canada	Training flight	84,950	25.40 μ Poly	Raven	N/A	N/A	N/A	Success
1020-P	23 May	Drs. J. Lockwood/ L. Friling Univ. of New Hampshire	Measurement of neutron and gamma-ray fluxes in the energy range 5-75 MEV and 1-12 MEV	329,213	12.70 μ Poly	Winzen	995.6	17.0	4.1	Success
1021-PT	23 May	Mr. K. Lamb SED Systems, Canada	Training flight	84,950	25.40 μ Poly	Raven	N/A	N/A	N/A	Success
1022-PT	26 May	S. Smith NSBF-Engineering	Sky Anchor flight	14,160 5,132	19.00 μ Poly 46.00 μ Celenar	Raven	145.0	45.0	14.0	Success
1023-P	1 June	Dr. G. Fazio Center for Astrophysics	Test of a digital star tracker	160,179	25.40 μ Poly	Winzen	2249.1	N/A	N/A	Balloon Failure Going Into Float
1024-P	6 June	Drs. W. Hofmann/ D. Lemke Max-Planck Institute	Infrared telescope	32,000	25.00 μ Poly	Raven	585.7	8.5	17.8	Success
1025-P	8 June	Dr. A. Potter/ NASA-JSC	Atmospheric science	113,300	13.00 μ Poly	Raven	261.7	N/A	N/A	Balloon Failure Ground Abort
1026-P	10 June	L. Sidwell - JPL	Solar cell calibration	65,129	17.78 μ Poly	Winzen	192.8	5.0	4.95	Success
1027-P	14 June	Dr. J. Anderson, Univ. of Michigan J. Stanley, NASA-JSC	Stratospheric measurement program	727,514	12.70 μ Poly	Winzen	819.6	0.3	2.04	Success
1028-P	25 June	Dr. F. Low Univ. of Arizona	Far infrared telescope	14,160	25.00 μ Poly	Raven	238.0	4.0	19.5	Success
1029-P	2 August	Dr. F. Low Univ. of Arizona	Far infrared telescope	14,160	25.00 μ Poly	Raven	249.0	8.0	19.8	Success
1030-P	11 August	L. Sidwell - JPL	Solar cell calibration	65,129	17.78 μ Poly	Winzen	182.0	3.5	5.15	Success
1031-PT	17 August	J. Ingram - NSBF	Training flight	142,292	25.40 μ Poly	Winzen	904.0	N/A	N/A	Success
1032-P	31 August	J. Stanley NASA-JSC	Parachute drop test	720.5			121.0	N/A	N/A	Success
1033-PT	2 September	S. Smith NSBF-Engineering	Sky Anchor test	14,160 5,132	19.00 μ Poly 46.00 μ Celanar	Raven	157.0	N/A	N/A	Ground Abort
1034-P	3 September	R. Staubert Univ. of Tubingen	Observation of extrasolar x-ray sources in the energy range of 15-150 KEV	437,341	12.70 μ Poly	Winzen	684.0	8.0	2.50	Success

SUMMARY OF FLIGHTS

FLIGHT NUMBER	DATE	EXPERIMENTER & ORGANIZATION	TYPE OF EXPERIMENT	BALLOON VOLUME (M^3)	GAUGE & MATERIAL	MANUFACTURER	PAYLOAD WEIGHT (KGS)	FLOAT TIME (HRS)	PRESSURE FLOAT ALT. (MB)	FLIGHT SUCCESS
1035-P	20 September	Dr.R. Staubert Univ. of Tubingen	Observe extrasolar x-ray sources in the energy range of 15-180 KEV with respect to spectral and temperal characteristics	436,128	12.70 μ Poly	Winzen	714.4	17.6	2.55	Success
1036-P	20 September	Dr. J. Anderson Univ. of Michigan/ J. Stanley,NASA-JSC	Atmospheric sciences	329,213	12.70 μ Poly	Winzen	831.0	.5	2.45	Success
1037-P	29 September	Drs. J. Nishimura Univ. of Tokyo and J. Lord, Univ. of Washington	Detection of high energy electrons beyond 1 TeV	329,213	12.70 μ Poly	Winzen	1088.6	29.2	4.35	Success

SUMMARY OF FLIGHTS

FLIGHT NUMBER	DATE	EXPERIMENTER & ORGANIZATION	TYPE OF EXPERIMENT	BALLOON VOLUME (M^3)	GAUGE & MATERIAL	MANUFACTURER	PAYLOAD WEIGHT (KGS)	FLOAT TIME (HRS)	PRESSURE FLOAT ALT. (MB)	FLIGHT SUCCESS
125-N (Sicily)	29 July 1976	Dr. D. Brini TESRE, CNR	X-ray and cosmic ray experiment	595,214	15.24 μ Poly	Winzen	1814.5	N/A	N/A	Electronics Failure
126-N (Sicily)	13 August	Max-Planck Inst. Univ. of Milano, Univ. of Chicago	X-ray detectors	594,214	15.24 μ Poly	Winzen	1770.4	84.0	4.1	Success
127-NT (Page, Arizona)	19 January 1977	S. Smith, NSBF	Test for Sky Anchor System	117,091	12.70 μ Poly	Winzen	612.4	7.0	5.5	Success
128-N (Australia)	23 March	Dr. C. Farmer JPL	Stratospheric trace gas composition	736,238	12.70 μ Poly	Winzen	1100.0	24.0	2.2	Success
129-N (Aberdeen, S.D.)	25 March	Dr. C. Orth Univ. of California Berkeley	Cosmic ray	628,704	20.32 μ Poly	Winzen	2388.0	N/A	N/A	Balloon Failure Ground Abort
130-N (Aberdeen, S.D.)	5 April	Dr.C. Orth Univ. of California Berkeley	Cosmic ray	628,704	20.32 μ Poly	Winzen	2388.5	N/A	N/A	Balloon Failure Ground Abort
131-N (Malden,Mo.)	10 May	Drs. N. Lund, B. B. Peters Danish Space Research Inst.	Cosmic ray	433,488	12.70 μ Poly	Winzen	1275.6	12.9	4.0	Success
132-N (Aberdeen, S.D.)	20 May	Dr. J. Waddington Univ. of Minnesota	Cosmic ray	937,906	12.70 μ Poly	Winzen	1220.3	55.8	2.15	Success
133-N (Aberdeen, S. D.)	28 May	Drs. C. Orth and A. Buffington Univ.of California Berkeley	Cosmic ray	612,093	22.86 μ Poly	Winzen	2358.0	8.3	5.6	Balloon Failure At Float
134-N (Aberdeen, S.D.)	29 May	Drs. E. Stone and R. Vogt Caltech	Cosmic ray	883,967	12.70 μ Poly	Winzen	1746.3	N/A	N/A	Balloon Failure Ground Abort
135-N (Aberdeen, S.D.)	6 June	Drs. E. Stone and R. Vogt Caltech	Cosmic ray	329,213	17.78 μ Poly	Winzen	1320.0	12.5	5.6	Success
136-NT (Grenada, Miss.)	25 June	S.Smith, NSBF	Sky Anchor Test	117,091 35,483	12.70 μ Poly 38.00 μ Celanar	Winzen Raven	232.0	N/A	N/A	System Failure
137-N (Christchurch N.Z.)	28 July	Drs. L. Megill R. Williamson Utah State Univ.	X-ray radiation, cosmic ray ionization and ozone	5,131.5	46.00 μ Celanar	Raven	20.0	Floating	21.0	Success

SUMMARY OF FLIGHTS

FLIGHT NUMBER	DATE	EXPERIMENTER & ORGANIZATION	TYPE OF EXPERIMENT	BALLOON VOLUME (M^3)	GAUGE & MATERIAL	MANUFACTURER	PAYLOAD WEIGHT (KGS)	FLOAT TIME (HRS)	PRESSURE FLOAT ALT. (MB)	FLIGHT SUCCESS
138-N (Christchurch, N.Z.)	11 August	Drs. L.Megill and R. Williamson Utah State Univ.	X-ray radiation, cosmic ray ionization and ozone	5,131.5	46.00 μ Celanar	Raven	20.0	31 Days	21.0	Success
139-N (Christchurch, N.Z.)	26 August	Drs. L. Megill and R. Williamson Utah State Univ.	X-ray radiation, cosmic ray ionization and ozone	5,131.5	46.00 μ Celanar	Raven	20.0	Floating	21.0	Success
140-N (Pierre, S.D.)	13 September	Dr. M. Israel Washington Univ.	Cosmic ray	1,121,350	20.00 μ Poly	Winzen	2868.0	40.0	3.9	Success
141-N (Malden, Mo.)	26 September	Dr. N. Lund Danish Space Research Inst.	Cosmic ray	441,800	15.24 μ Poly	Winzen	1288.6	41.0	4.30	Success

APPENDIX B

ATMOSPHERIC SCIENCES

Dr. James R. Benbrook, University of Houston

Flight 981-P, 1 September 1976

Purpose: Our payload was designed to measure the vector electric and magnetic fields propagating toward the ionosphere from lightning discharges. In addition, the low energy x-ray flux and the local conductivity were measured during ascent. The data obtained will be used to test simple models for propagation of VLF waves toward the ionosphere.

Results: One small lightning stroke was observed during an eleven and one-half hour flight. The weather did not cooperate as planned. The payload will be flown again in September, 1977.

Publications: The conductivity data are being included in a publication covering balloon flights from NCAR-Palestine and Roberval, Quebec. The paper will be submitted to JGR this fall.

Dr. Eugene J. Maier, Goddard Space Flight Center

Flight 1014-P, 26 April 1977

Purpose: The purpose of this flight was to test the use of in-situ photoionization mass spectrometry for measuring trace species in the stratosphere. Certain nitrogen compounds, NO, NO_2, HNO_3, and others, are critical to the chemistry which determines the concentration of the ozone in the upper atmosphere. A photoionization mass spectrometer was implemented to measure the concentration of nitric oxide in conjunction with the measurement of ambient ozone by a Dasibi ozone monitor.

Results: The flight was fully successful, yielding a nitric oxide profile on the descent from peak height (38 km) until the ambient NO was below the detectability level of the instrument. Variations observed in the NO concentration are being studied in conjunction with the observed ozone profile to develop a better understanding of stratospheric photochemistry and dynamics. In addition to the nitric oxide data obtained, several unanticipated peaks were found at other masses in the spectra. These are being studied.

COSMIC RAY EXPERIMENTS

Dr. Niels Lund, Danish Space Research Institute

Flight 131-N, 10 May 1977

Purpose: The flight had the dual purpose of achieving a final technical verification of the detector configuration to be flown on the NASA HEAO-C statellite in 1979 and to obtain scientific results on the precise shape of the geomagnetic cut off at rigidities around 3 GV.

Results: The detector configuration performed very well, in particular the on-board event selection system provided much cleaner data than obtained in an earlier test flight in October 1975. However, an electronic failure limited the useful data collection time at ceiling to about 5 hours, and this will severely restrict the analysis of the geomagnetic effects.

Publications: No publications are as yet derived from this flight.

Two publications during the past 12 months have dealt with data obtained in earlier balloon flights:

1) Measurements of the Li/B abundance ratio above 650 MeV/ nucleon, B. Byrnak, N. Lund, I.L. Rasmussen, and M. Rotenberg.

2) Penumbra structure calculations and their application to isotope analysis of Cosmic Rays, Niels Lund and Amos Sorgen

Both to appear in Proc. of the 15 Int. Cosmic Ray Conference, Plodiv, Bulgaria 1977.

Dr. C. J. Waddington, University of Minnesota

Flight 132-N, 20 May 1977

Purpose: The purpose of this flight was to study the isotopic composition of cosmic ray nuclides between silicon and nickel in an energy region between 300 and 800 MeV per nucleon. A secondary purpose was to study the nuclear interactions produced by cosmic ray nuclei of accurately known charge in nuclear photographic emulsions.

Results: Some sixty hours of data were taken at float altitude and the equipment was recovered undamaged. All systems worked perfectly throughout the flight. Telemetry was obtained for all but 4 hours and these data will be recoverable from the onboard spark chamber film. The spark chambers show no degradation through the flight and reduction of the film is already underway. The nuclear emulsions are still being processed, but those that have been completed are in good shape in spite of their total 130 hours of exposure. The electronic data is now all on computer tapes and preliminary data analysis has begun.

Publications: The following publication has resulted in the past year from flights carried out by the NSBF.

"Intensity of Primary Cosmic Ray Electrons of Energy Greater than 8 GeV" Phyllis Freier, Charles Gilman and C. J. Waddington, Astrophys. J. 213, 588-599 (1977).

Drs. E. C. Stone and R. E. Vogt, California Institute of Technology

Flight 135-N, 6 June 1977

Purpose: This flight was made to evaluate the performance of the Caltech High Energy Isotope Spectrometer Telescope (HEIST) and to make measurements of the isotopic composition of the cosmic radiation in the charge range $3 \leq Z \leq 28$ and the energy range from 30 to 800 MeV/nuc. In addition to providing scientific data the flight was intended to yield engineering information useful for evaluating the thermal, mechanical and electrical design of the scientific package.

Results: This flight was carried out with an 11.6×10^6 ft^3 balloon which was substituted when the planned 31×10^6 ft^3 balloon split during launch of flight 134-N. The performance of the second balloon was poorer than expected, resulting in an altitude profile which peaked at 5.7 mb, followed by a gradual descent to $\sim$ 21 mb over a period of $\sim$ 13 hr. As a result, minimal scientific data were acquired, but the flight did provide valuable engineering tests of the instrument.

Dr. Jere J. Lord, University of Washington, and Dr. Jun Nishimura, University of Tokyo

Flight 986-P, 23 September 1976

Purpose: The purpose of this flight was to measure the energy spectrum and intensity of high energy cosmic ray primary electrons. The goal of the experiments was to obtain significant and accurate information on the intensity at energies from 300 GeV to 1,000 GeV.

Results: The flight remained at ceiling altitude for about 25 hours and the average depth in the atmosphere was 3.9 g/cm^2. About two to three times more data was obtained than the total of the world's data for electrons of energies over 300 GeV.

Publications: The results of the observations were presented in a paper at the 1977 Washington, D. C. meeting of the American Physical Society and a paper will be presented at the August 1977 International Cosmic Ray Conference. Nishimura, Fujii, Aizu, Hiraiwa, Taira, Kobayashi,

Niu, Koss, Lord, Wilkes, and Golden; Bull. Am. Phys. Soc. 22,601, 1977

Paper OG 1-7-100, Proceedings of the 15th International Cosmic Ray Conference, Plovdiv, Bulgaria, August 13-26, 1977.

Drs. J. F. Arens, V. K. Balasubrahmanyan and J. F. Ormes, Goddard Space Flight Center, Drs. M. Simon, H. Speigelhauer and W. Schmidt, Max-Planck Institute

Flight 992-P, 11 October 1976

Purpose: These flights were carried out in order to measure the composition and energy spectra of heavy cosmic ray nuclei in the range 50 to 300 GeV/nucleon. This will determine the extent and importance of differences in spectra of different components of the radiation. We should learn about the sources of the particles and how they are accelerated. In particular we are looking for effects which might indicate that these particles come from the surfaces of pulsars, rapidly rotating neutron stars with intense magnetic fields.

Results: Analysis of these results is still in progress and should be completed this year. The data from the flight is excellent. Good charge resolution has been obtained. Trajectories have been determined from a sequence of position sensitive scintillators. The next step will be the derivation of energy spectra. Preliminary results will be presented at the 15th International Cosmic Ray Conference in Munich, and publications will follow:

Publications: Proc. 15th Intnl. Conf. on Cosmic Rays, Cosmic Ray Composition Between 5 and 300 GeV/Nucleon. J. F. Arens[1], V. K. Balasubrahmanyan[1], J. F. Ormes[1], W. K. H. Schmidt[2,3], M. Simon[3], F. Siohan[2], H. Speigelhauer[3], G.B. Yodh[1,4]

1 NASA-Goddard Space Flight Center
2 Max-Planck Institute fur Extraterrestrische Physics
3 MAS/NRC Resident Research Associate at NASA/GSFC
4 Physics Department, University of Maryland

High Energy Cosmic Ray Iron Spectrum Experiment, J. F. Arens[a)] V. K. Balasubrahmanyan[a)], J. F. Ormes[a)], W. K. H. Schmidt[b)], M. Simon[c)] H. Spiegelhauer[d)]

a) NASA/Goddard Space Flight Center
b) NAS/NRC Research Associate at NASA/GSFC
c) Gesamthochschule Siegen, West Germany
d) Max-Planck Institute fur Extraterrestrische Physik

The experiment planned for flight from the NSBF during September-October is also being described in the same proceedings: Proton

and Helium Spectra from 100 GeV to 10^5 GeV: A planned Experiment.

R. W. Ellsworth, J. Goodman, P. Vishwanath, R. E. Streitmatter and G. B. Yodh, Department of Physics and Astronomy, University of Maryland, V. K. Balasubrahmanyan, J. Ormes, J. F. Arens and F. Siohan, NASA-GSFC, Laboratory for High Energy Astrophysics.

GAMMA AND X-RAY EXPERIMENTS

Dr. G. Frye, Case Western Reserve University

Flight 991-P, 9 October 1976

Purpose: The basic purpose was to observe gamma-ray sources above 10 MeV for R. A. from 0 to 10 hours, 5^o to 70^o in declination, with particular emphasis on the Crab and other radio pulsars in that part of the sky. The flight was the first with our one sq. meter MWPC gamma-ray telescope.

Results: The new instrument operated successfully at the float altitude of 1.6 mbar for the flight duration of ten hours. Some 10^6 photon events were recorded of which 10^3 are pulsed events from the Crab. Analysis of the data is continuing.

Publications: "A Spark Chamber and Time-of-Flight Detector for 15-150 Mev Neutrons from an Extended Source", A. D. Zych, M.A. Nazaretz, J. S. Vogel, G. M. Frye, P. Albats, R. S. Schreiner and G. B. Thomson, Nuclear Instruments and Methods (to be published) 1977.

"Observations with a One Square Meter Balloon-Borne Gamma-Ray Detector in the Energy Range above 10 MeV", P. Albats, B. Denehy, G. M. Frye, T. Jenkins, R. Koga, and S. M. Schindler, 12th ESLAB Symposium, Frascati, May, 1977.

Dr. Franco Fuligni, Lab. TESRE, Consiglio Nazionale Delle Richerche, Bologna, Italy

Flight 997-P, 10 November 1976

Purpose: The purpose of this flight was to carry out an accurate measurement of the energy spectrum of the diffuse cosmic x-ray background in the range from 20 to 200 keV, and to obtain information on the source function of energetic photons in atmosphere. This data will also be used in the attempt of understanding systematic discrepancies in the slope of spectra obtained in measurement inside and outside the atmosphere.

Results: Analysis of data is at present in progress. Preliminary results, presented at the meeting of the Italian Physical Society, show that data collected are of very good quality, so that there is hope to reach our goals.

Publications: Preliminary results have been used for the following paper: "Preliminary Application of a New Method for the Analysis of Balloon-Borne Diffuse Background Measurements". E. Moretti-Horstman and H. H. Horstman, Proc. of 12th ESLAB Symp., Frascati, May 1977.

Drs. M. R. Pelling, University of California, San Diego, and M. Oda, University of Tokyo, Japan

Flight 1007-P, 2 February 1977

Purpose: The objective of this balloon flight was to measure the spatial distribution of high energy X-rays from the Crab Nebula which is the 1000 year old remnant of a supernova explosion. The data should permit a detailed study of energetic processes occurring within the nebula and the relationship of the nebula to the central energizing pulsar.

Results: Approximately three hours of float observations were obtained before the payload moved out of upwind telemetry range. Preliminary analysis of the data indicates that the apparatus operated satisfactorily and that position angles 120 to 150 degrees on the Crab were successfully scanned.

Publications: "High Energy X-Ray Observations of NGC 4151 with a Balloon Borne Telescope", Paciesas, W. S., Mushotzky, R. F., and Pelling, R. M., Mon. Not. R. Astr. Soc. 178, 23, 1977.

"Intensity and Spectral Variations of Cyg X-1 Observed from Balloons", Matteson, J. L., Mushotzky, R. F., Paciesas, W. S., and Laros, J. G., X-Ray Binaries, NASA Sp-389, 1976.

Observations of Her X-1 Above 20 keV , Paciesas, W. S. and Pelling, R. M., Bull. A.A.S., 8, 512, 1976.

Drs. C. Meegan and G. Fishman, NASA - Marshall Space Flight Center

Flight 1017-P, 11 May 1977

Purpose: The purpose of the flight was to determine the spatial distribution of the sources of the cosmic gamma-ray bursts by measuring the frequency of weak bursts, and to determine pulse profiles of x-ray pulsars.

Results: Time at float was 14 hours. The detector preformed satisfactorily. Good data were obtained during all but the last two hours, when the telemetry was weak. Pulsar and bursts searches are currently in progress.

Publications: "Observations of a North-South Anisotropy at Atmopsheric Radiation at Balloon Altitudes", G. J. Fishman, J. W. Watts, Jr., and C. A. Meegan, J. Geophys. Res., 81, 6121 (1976)

"The Hard X-Ray Pulse Profile of the Transient Source A 0535+26", G. J. Fishman and J. W. Watts, Jr., Ap. J, 212, 211 (1977).

Dr. John A. Lockwood, University of New Hampshire

Flight 1020-P, 23 May 1977

Purpose: To measure the 1-15 MeV gamma ray flux and the flux, energy spectrum and angular distribution of 3-70 MeV nuetrons at the top of the atmosphere.

Results: The flight was successful, the data of excellent quality, but the duration was only 5 hours at float due to battery failure. The results were presented in a preliminary fashion at the International Cosmic Ray Conference, Plovdiv, 1977, and further, more detailed analysis is in progress.

Publications: Neutron Leakage Flux 3-70 MeV, 15th Int. Cosmic Ray Conf., (Plovdiv), 1977.

INFRARED EXPERIMENTS

Dr. R. Weiss, Massachusetts Institute of Technology

Flight 908-P, 1 July 1975 (not reported in FY 1976 Annual Report)

Purpose: A sky survey at mm and sub mm wavelengths.

Results: A partial sky survey was performed with a balloon-borne, far-infrared differential radiometer. The instrument had a beam-width of 1.6^{o} FWHM and two spectral responses: 1-9 cm^{-1} and 6-21 cm^{-1}. Scans were made across the Galactic plane from longtitude 358^{o} -42^{o} and 80^{o} -130^{o}. Scans were also made across three Friedlander sources and the plane of the ecliptic. No sources were detected in the 1-9 cm^{-1} spectral band at a limit of 4×10^{-11} W/m^2 for the Galactic plane and 1×10^{-10} W/m^2 for the rest of the area covered. The Galactic plane from $\ell^{II}=358^{o}$ to 42^{o} was detected

in the 6-21 cm^{-1} spectral band. No other sources were detected in this spectral band at a limit of $3x10^{-11}$ W/m^2 for the Galactic plane and $1.3x10^{-10}$ W/m^2 for the rest of the area covered. The flux from the Galactic center was measured as $4.1x10^5$ J. The sources are interpreted as dust clouds. The two spectral responses are used to set limits on the allowable dust temperature or the power law behavior of the dust emissivity. The inferred temperature of the extended cloud at the Galactic center is found to be from 18 K to 32 K.

Publications: Kingston Owen, PhD Discertation, M.I.T., to be published in Ap.J.

Flight 910-P, 9 July 1975 (not reported in FY 1976 Annual Report)

Purpose: To measure large scale anisotrophies in the cosmic background radiation. The instrument is a dual channel ($3 \rightarrow 10$ mm^{-1} and 10 $mm^{-1} \rightarrow 25$ mm^{-1}) differential radiometer with a sensitivity of 1×10^{-1} $O_{\frac{1}{2}}/H_2{}^{\frac{1}{2}}$ in the low frequency channel.

Results: Failure of the let down reel due to launch difficulties resulted in the package being too close to the balloon. The reflections by the balloon produced excessive noise in the data.

Dr. William F. Hoffmann, University of Arizona

Flight 978-P, 4 August 1976

Purpose: The purpose of this flight was to test a new 40 cm liquid helium cooled infrared telescope and associated detectors and to observe faint cool galactic objects in the far infrared.

Results: The telescope worked as expected achieving sky background limited sensitivity at a wavelength of 100 microns. Nine infrared sources were detected, eight of which are new far infrared discoveries. Further flights are planned for a systematic survey of the galactic plane.

Publications: "Discovery of Far-Infrared Sources with a New Balloon-Borne Helium-Cooled .4-Meter Telescope", M. F. Campbell, P. M. Harvey, W. F. Hoffmann, M. R. Jacobson, D.B. Ward, M. O. Harwit, P. A. Aannestad. Recent Results in Infrared Astrophysics, NASA Ames Research, (in Press).

"Balloon-Borne Telescopes for Far-Infrared Astronomy" Infrared and Submillimeter Astronomy, p. 155-168 Dordrecht, D. Reidel & Co. (1977).

Drs. R. Weiss, D. J. Muehlner, Massachusetts Institute of Technology

Flight 982-P, 3 September 1976, Flight 984-P, 15 September 1976

Purpose: The purpose of 982-P was to measure the large scale angular

distribution of the cosmic background radiation at millimeter and sub-millimeter wave lengths. The purpose of 984-P was to map the sky with a resolution of $1.1/2^{o}$ at millimeter and sub-millimeter wave lengths.

Results: Flight 982-P is one of several flights which have shown that the background radiation is isotropic to the level of a part of a thousand; however, there are systematic "noise sources" at approximately that level which we are beginning to attribute to diffuse extended dust clouds in our galaxy. The results of 984-P are a map of the galactic plane extending from l_{11} -5^{o} to $+ 100^{o}$. The plane is not of uniform thickness varying from the minimum determined by the mean resolution of $1\ 1/2^{o}$ sections to as large as 8^{o} in width.

Publications: In preparation: "A Sky Survey at Millimeter and Sub-Millimeter Wave Lengths", K. Owens, D. J. Muehlner and R. Weiss.

Dr. John Strong, University of Massachusetts

Flight 993-P, 13 October 1976

Purpose: The object of this flight was to study the solar corona in the near infrared from 3 to 13 solar radius.

Results: We have a successful flight with the dual reflective coronagraph. The preliminary results indicate that the dust bumps do exist and their position on the curves corresponds with earlier findings on the location of the solar dust band.

Publications: From this flight: none to date (paper in progress). From prior flights: "Observations of the Near-Infrared Solar Corona, and a New Interferometric Telescope Test," Raymond N. Smartt, Ph.D. Dissertation, University of Massachusetts, February 1976.

Dr. R. D. Joseph, Imperial College, London

Flight 998-P, 29 November 1976, Flight 1003-P, 16 December 1976

Purpose: These were the maiden flights of two new systems, a far-infrared astronomy payload incorporating a 41" aperture telescope, and a stabilized balloon platform developed for the U. K. Science Research Council by GEL Marconi Electronics. In addition to extensive tests of the performance of both these systems we hoped they would work well enough to permit far-infrared photometry (45μ to 400μ wavelength) of various astronomical objects and especially of active galaxies.

Results: On both flights problems appeared which prevented deploying the telescope from the launch stow position. However, we were able to carry out crude roster scans using the sidereal motion of the sky to attempt to detect bright infrared sources, and in this way we detected Venus and Saturn. These permit calibration of the sensitivity of the infrared payload, which we find to be good. Other astronomical sources were scanned, and analysis of this data is still underway.

Publications: "The Imperial College 41-Inch Balloon Telescope for Far-Infrared Balloon Astronomy", by R. D. Joseph, J. Allen, P. S. Meikle, K. C. Sugden, M. F. Kessler, D. L. Rosen, and G. Masson, Optical Engineering (to be published in Nov./Dec. 1977).

Prof. P. L. Marsden, University of Leeds

Flight 1012-P, 22 April 1977

Purpose: To determine the spectral composition of the cosmic background submillimetre radiation (the 3K background radiation). The experiment consisted of a liquid helium cooled lamellar grating interferometer, resolution of 0.1 wave number covering the range 5-30 wave number.

Results: Verification of the correct functioning of the apparatus at float altitude was ascertained from calibration spectra. Twelve (12) interferograms on the background radiation were obtained before failure of battery after 3 hours at float terminated the programme. The data obtained are more noisy than expected and indicate an excessively large signal. Analysis of the results is still in progress.

Publications: A lamellar grating interferometer experiment to determine the spectrum of the cosmic background radiation.

"Far Infrared Astronomy", J. B. Mercer, S. Wilson, P. Chaloupka, W. K. Griffiths, P. Marchant, P. L. Marsden, and C. C. Morath, Ed. M. Rowan Robinson, Pergamon Press, pp 103-114, 1976.

Atmospheric emission as a check on the spectral measurements of the submillimeter background radiation.

"Far Infrared Astronomy, P. Marchant, Ed. M. Rowan Robinson, Pergamon Press, pp 145-147, 1976.

Dr. G. G. Fazio, Center for Astrophysics/Harvard College Observatory/ Smithsonian Astrophysical Observatory and Univ. of Arizona

Flight 1013-P, 25 April 1977

Purpose: Far infrared (40-250 micron) photometry and high

resolution (1 arc min) mapping of H II regions, molecular clouds, and supernova remnants. Photometry of the planets, particularly Uranus and Neptune, and asteroids.

Results: The flight was very successful, yielding 7.7 hours of observation with broadband (40-250 micron) photometer. The following regions or objects were observed: (a) Planets: Venus, Saturn, Uranus, and Neptune; (b) Supernovae Remnants: Crab Nebula and Cas A; (c) Asteroid: Ceres; (d) HII Regions: W42 and RCW 126; (e) Molecular Clouds: M17 SW. The data from this flight are presently being reduced. The pointing stability of the telescope, as measured by the gyro drift rate, was the best ever achieved during flight ($\leq$ 8 arcsec/min).

Publications: Observations of an Internal Heat Source on Neptune, M. T. Stier, W. A. Traub, G. G. Fazio and F. J. Low (Abstract) Meeting of Division of Planetary Sciences, A.A.S., Boston, October 1977.

From Previous Flights; Published in 1977:

(a) A New Infrared - CO Source in M8, E. L. Wright, C. J. Lada, G. G. Fazio, D. E. Kleinmann, and F. J. Low, Astronomical J., 82, 132 (1977).

(b) A High-Resolution Far-Infrared Survey of the W31 Region, E. L. Wright, G. G. Fazio, and F. J. Low, to be published Astrophys. J., 1977.

(c) A New, Compact Far-Infrared Source in the W31 Region, G. G. Fazio, C. J. Lada, D. E. Kleinmann, E. L. Wright, P.T.P. Ho, and F. J. Low, submitted to Astrophys. J. (Lett.), 1977.

Professor Paul L. Richards, University of California

Flight 1016-P, 3 May 1977

Purpose: The primary goal of this flight was to make a definitive measurement of the near-millimeter spectrum of the cosmic background radiation. The instrument also produced high resolution spectra of the night sky emission from the upper atmosphere in the wavelength range from 0.25 to 7.0 mm which was used to measure the molecular emission from H_2O, O_2, and O_3. In addition, the flight tested novel instrumentation techniques. These included the first flight of a ^{3}He cooled composite bolometer. This detector is an order of magnitude more sensitive than any near-millimeter detector previously flown.

Results: The flight was a complete success. Two and one-half hours of observing at a float altitude of 43 km were obtained. The instrument

performed flawlessly and excellent data were obtained on the molecular emission from the night sky and the cosmic background radiation. Preliminary data analysis indicates that we will be able to test atmospheric emission models down to the $\approx$ 1% level and provide a measurement of the near-millimeter cosmic background radiation which is several times better than the present measurement.

Publications: The following publication which was related to balloon flights carried out by NSBF appeared in the past year:

"Cosmology", P. L. Richards, McGraw-Hill Yearbook of Science and Technology, 1977, pp. 180-182.

OPTICAL AND UV ASTRONOMY

Drs. Yoji Kondo, NASA-Johnson Space Center, and C. de Jager, Space Research Laboratory, Utrecht

Flight 985-P, 16 September 1976

Purpose: The purpose of this flight was to obtain high resolution ($\lambda/\Delta\lambda = 3 \times 10^4$) mid-ultraviolet spectra of a number of selected stars employing a Balloon-Borne Ultraviolet Stellar Spectrometer (BUSS). BUSS payload consists of a 40-cm aperture, tilted aplantic reflector with a dual star-tracking system equipped with an echelle spectrograph and an SEC Vidicon as the detector systems.

Results: The 10-hour flight produced 30 high resolution spectra of 24 stars. The experiment was carried out very successfully.

Publications: The following four papers have been presented at three meetings of the American Astronomical Society over the past year. In addition, three symposium papers have been presented. Three journal articles are nearing completion for submission. They will be followed by a number of publications using the results of two BUSS flights in 1976.

"Balloon-Borne High Resolution Ultraviolet Stellar Spectrophotometry Utilizing Echelle Spectrograph and SEC Vidicon", Y. Kondo, C. de Jager, T. H. Morgan, K. A. van der Hucht, and J. L. Modisette, (Abstract) Bull. Amer. Astron. Soc., 8, 428, (1976).

"Balloon-Borne High Resolution Ultraviolet Spectrophotometry Utilizing Echelle Spectrograph and SEC Vidicon II", Y. Kondo, J. L. Modisette, T. H. Morgan, C. de Jager, H. J. Lamers, and K. A. van der Hucht, (Abstract) Bull. Amer. Astron. Soc., 8, 548 (1977).

"BUSS Observations I. The Near Ultraviolet Spectrum of α Sco AB", (Abstract), K. A. van der Hucht, H. J. Lamers, C. de Jager, Y. Kondo, T. H. Morgan and J. L. Modisette, Bull. Amer. Astron. Soc., 8, 543 (1977).

"BUSS Observations II. Extended Atmospheres of Betelgeuse" (Abstract) Y. Kondo, J. L. Modisette, T. H. Morgan, C. de Jager, H. J. Lamers, and K. A. van der hucht, Bull. Amer. Astron. Soc., 9, 365 (1977).

OTHER

Dr. R. G. Downing, Jet Propulsion Laboratory

Flight 1000-P, 3 December 1976

Purpose: Calibrate celestial solar cells at an altitude of 120,000 feet using an apex mounted solar tracker.

Results: Launch, flight and landing were successful. Because of a failure in the solar tracker system (investigator provided) no cells were calibrated.

Mr. Louis B. Sidwell, Jet Propulsion Laboratory

Flight 1026-P, 10 June 1977

Purpose: Calibrate celestial solar cells at an altitude of 120,000 feet using a top mounted solar tracker.

Results: Four or five cells lost because of separation failure at termination, balance of cells (30) were calibrated and the flight was termed successful.